Waubonsie Creek Site Specific Restoration Project
Illinois River Ecosystem Restoration
Alternatives Report

INTRODUCTION

1. Project Authority.
The Waubonsie Creek Site Specific Restoration Project is being conducted as a component of the Illinois River Ecosystem Restoration Feasibility Study and Illinois River Basin Restoration. The Illinois River Ecosystem Restoration Study is a General Investigation study authorized by Section 216 of the Flood Control Act of 1970. Supplemental authority was provided by Section 519 (Illinois River Basin Restoration) of the Water Resources Development Act of 2000 which authorizes implementation of critical restoration projects such as the Waubonsie Creek Site Specific Restoration Project.

2. Project Location.
Waubonsie Creek is located in northeastern Illinois. Waubonsie Creek originates in the southwest corner of DuPage County and flows southwest to its confluence with the Fox River in the Village of Oswego, Illinois. The watershed drains portions of Kane, Kendall, DuPage and Will Counties.

3. Resource Problems and Opportunities.
Waubonsie Creek is approximately 10.8 miles long with a watershed of approximately 29.6 square miles. The relief is nearly level to gently sloping, but more sloping and steeper areas occur along Waubonsie Creek, especially near the confluence with the Fox River. Following European settlement, the watershed experienced drainage and channelization to maximize agricultural production. The watershed is now experiencing urbanization. The upper portion of the watershed has the residential, commercial and light industrial developments; the middle portion is a mix of residential, commercial and agricultural; and the lower portion is primarily cropland, but is now experiencing residential development adjacent to the creek upstream from Oswego. Five dams were constructed on the steeper downstream portions of the creek. The Lower Stonegate Dam and Lower Pfund dam failed during an extreme flood event in 1996; however, the Upper Stonegate, Upper Pfund and Fox Valley Golf Course dams are still in place.

Land use changes have reduced stream length and instream diversity. Agricultural and urban development have impacted upland and riparian wetlands, altered flow regimes and encroached upon the riparian corridor. The dams have prevented Fox River fish from utilizing spawning habitat available in the steeper downstream reaches. The dams also prevent re-colonization of fish and mussels from the Fox River after extreme flow events.

There is the opportunity to restore stream connectivity by modifying or removing the dams. Four of the five dams are in public ownership and the pools they create are not required. As agricultural lands are converted to residential development, developers are transferring ownership of portions of the riparian corridor to the Oswegoland Park District and Fox Valley Park District. The Village of Montgomery owns a detention facility adjacent to Waubonsie Creek. These public areas offer an opportunity to restore some riparian wetlands and increase instream diversity.

PROJECT GOALS, OBJECTIVES AND POTENTIAL FEATURES

1. Project Goals and Objectives.
The following goals, objectives and potential enhancement features were identified:

Table 1. Project goals, objectives and potential features.

Goal	Objective	Potential Features
Restore aquatic habitat	Provide fish passage, restore connectivity	Dam removal Fish passage structure
	Increase instream habitat	Meander channelized stream sections
Restore riparian habitat	Restore/create riparian wetlands	Install riffles Create off-channel refuge Install streambank structures Create floodplain wetlands

The primary goals identified were 1) restoration of aquatic habitat and 2) restoration of riparian habitat. The objectives included 1) providing fish passage at the dams to restore stream connectivity, 2) increasing instream habitat, and 3) restore or create riparian wetlands.

2. Potential Project Features and Measures

Potential project features are listed in Table 1.

- Dam removal would allow fish from the Fox River to access spawning habitat in the steep, rocky portions of the stream, would allow recolonization of Waubonsie Creek by fish and other macroinvertebrates following extreme flow events and would eliminate the artificially pooled habitat that accumulates sediment behind the dams.
- Fish Passage Structures would also allow access to spawning habitat and recolonization of Waubonsie Creek following extreme flow events that flush fish and mussels downstream. The structures would provide a more gradual slope over the dams and providing areas with lower velocities behind large rocks where fish can rest. Fish passage structures consisting of rock ramps downstream of the dams would also provide additional spawning habitat.
- Meander channelized stream sections would restore instream diversity with meander bends and channel crossovers; increase stream length; and decrease stream slope.
- Riffles would introduce stream diversity to channelized sections by creating self-scouring deep pools behind the riffles and oxygenating water as it breaks over the rock riffles. Diverse aquatic insects would utilize the rocky substrate of the riffles.

- Create off-channel refuge would provide refuge from flows during flood events so fish would not be flushed downstream to the Fox River. These areas would also provide wetland habitat for birds, small mammals, small fishes and invertebrates.
- Install streambank structures would increase instream diversity by providing shelter habitat for fish.
- Create floodplain wetlands would provide habitat for birds, small mammals and invertebrates. Wetland creation could increase the diversity of wetland plants in floodplain areas that are dominated by monocultures of invasive species such as reed canary grass. Wetlands also have the ability to remove nutrients from the water and thus improve water quality.

The above restoration features were proposed at the following restoration sites: Upper and Lower Stonegate Dams, Upper and Lower Pfund Dams; Fox Valley Golf Course Dam; Oswegoland Parkway; Parkview Estates detention pond; and Fox Valley Greenway. Restoration features were combined to develop restoration measures at each site. Restoration measures will then be evaluated based on cost and habitat benefit.

a. **Stonegate Restoration (S)**. The measures designated by the letter "S" represent increments of restoration at the Upper Stonegate and Lower Stonegate Dam Sites. These measures are described below.

Alternative Measures
Stonegate
S0 – no action
S1 – extend ramp
S2 – notch dam and extend ramp
S3 – extend ramp, add lower riffle
S4 – notch dam, extend ramp, add lower riffle

No action (S0). This measure would result in no additional management efforts beyond the existing practices. The Lower Stonegate Dam has been modified since its failure, but the slope of the downstream face is 7.5H:1V which is steeper than is optimal for fish passage. The two constructed riffles (upper and lower riffle) located between the Upper and Lower Stonegate Dams are also steeper than is optimal for fish passage. The Upper Stonegate Dam is in place and prevents upstream movement of fish in most flow conditions.

Extend Lower Stonegate Ramp (S1). This measure would involve extending the ramp downstream of the Lower Stonegate Dam to a 20H:1V slope which is optimal for fish passage. The upper and lower riffles would be modified to create a 20H:1V slope on the downstream face and a 4H:1V slope on the upstream face and keyed into the streambanks. The left descending streambank downstream of the Upper Stonegate Dam would be armored to prevent the stream from creating a new channel bypassing the upper and lower riffle structures. A rock ramp with a 20H:1V slope on the downstream face would be constructed downstream of the Upper Stonegate Dam to provide fish passage.

Notch Lower Stonegate Dam and Extend Ramp (S2). This measure would involve cutting a notch in the Lower Stonegate Dam and extending the ramp downstream to a 20H:1V slope. Given the same ramp slope, the notch would reduce the length of the ramp and thus the swimming distance for fish to pass over the ramp. The upper and lower riffles would be modified to create a 20H:1V slope on the downstream face and a 4H:1V slope on the upstream face and keyed into the streambanks. The left descending streambank downstream of the Upper Stonegate Dam would be armored to prevent the stream from creating a new channel bypassing the upper and lower riffle structures. A rock ramp with a 20H:1V slope on the downstream face would be constructed downstream of the Upper Stonegate Dam to provide fish passage.

Extend Lower Stonegate Ramp, Add Lower Riffle (S3). This measure would involve extending the ramp downstream of the Lower Stonegate Dam to a 20H:1V slope which is optimal for fish passage. A riffle would be constructed downstream of the Lower Stonegate. The downstream riffle breaks the rise into two steps and provides a resting pool upstream of the downstream riffle. The upper and lower riffles would be modified to create a 20H:1V slope on the downstream face and a 4H:1V slope on the upstream face and keyed into the streambanks. The left descending streambank downstream of the Upper Stonegate Dam would be armored to prevent the stream from creating a new channel bypassing the upper and lower riffle structures. A rock ramp with a 20H:1V slope on the downstream face would be constructed downstream of the Upper Stonegate Dam to provide fish passage.

Notch Lower Stonegate Dam and Extend Ramp (S4). This measure would involve cutting a notch in the Lower Stonegate Dam and extending the ramp downstream to a 20H:1V slope. Given the same ramp slope, the notch would reduce the length of the ramp and thus the swimming distance for fish to pass over the ramp. A riffle would be constructed downstream of the Lower Stonegate. The downstream riffle breaks the rise into two steps and provides a resting pool upstream of the downstream riffle. The upper and lower riffles would be modified to create a 20H:1V slope on the downstream face and a 4H:1V slope on the upstream face and keyed into the streambanks. The left descending streambank downstream of the Upper Stonegate Dam would be armored to prevent the stream from creating a new channel bypassing the upper and lower riffle structures. A rock ramp with a 20H:1V slope on the downstream face would be constructed downstream of the Upper Stonegate Dam to provide fish passage.

b. **<u>Pfund Restoration (F).</u>** The measures designated by the letter “F” represent increments of restoration at the Upper Pfund and Lower Pfund Dam Sites. These measures are described below.

Pfund
F0 – no action
F1 – remove dam and replace with riffle
F2 – construct ramp on downstream dam face
F3 – remove dam, replace with riffle, add lower riffle
F4 – construct ramp on downstream face and add lower riffle

No action (F0). This measure would result in no additional management efforts beyond the existing practices. The Lower Pfund Dam failed in 1996, but the remains of the concrete structure still lie in the channel. This structure currently does not block movement; however, in the future high flow events the structure could shift in the channel and again block fish movement. The Upper Pfund Dam is in place and prevents upstream movement of fish in most flow conditions.

Remove Upper Pfund Dam and Replace with Riffle (F1). The Upper Pfund Dam would be removed and replaced with a riffle structure with 20H:1V slope on the downstream face and a 4H:1V slope which is optimal for fish passage. The debris of the Lower Pfund Dam would be removed.

Construct Ramp on Upper Pfund Dam (F2). The Upper Pfund Dam would be modified to provide fish passage by constructing a 20H:1V rock ramp on the downstream face and a 4H:1V slope on the upstream face of the dam. The dam would be left in place and the rock would help stabilize it. A stone weir would be placed in the stoplog structure opening. The debris of the Lower Pfund Dam would be removed.

Remove Upper Pfund Dam, Replace with Riffle, Construct Downstream Riffle (F3). The Upper Pfund Dam would be removed and replaced with a riffle structure with 20H:1V slope on the downstream face and a 4H:1V slope which is optimal for fish passage. A second riffle would be constructed downstream of the first riffle. The downstream riffle breaks the rise into two steps and provides a resting pool upstream of the downstream riffle. The debris of the Lower Pfund Dam would be removed.

Construct Ramp on Upper Pfund Dam, Construct Downstream Riffle (F4). The Upper Pfund Dam would be modified to provide fish passage by constructing a 20H:1V rock ramp on the downstream face and a 4H:1V slope on the upstream face of the dam. The dam would be left in place and the rock would help stabilize it. A stone weir would be placed in the stoplog structure opening. A riffle would be constructed downstream of the Upper Pfund Dam. The downstream riffle breaks the rise into two steps and provides a resting pool upstream of the downstream riffle. The debris of the Lower Pfund Dam would be removed.

c. **<u>Fox Bend Golf Course Restoration (G).</u>** The measures designated by the letter “G” represent increments of restoration at the Fox Bend Golf Course Dam. These measures are described below.

Fox Bend Golf Course
G0 – no action
G1 – ramp downstream face of dam

No action (G0). This measure would result in no additional management efforts beyond the existing practices. The Fox Bend Golf Course Dam would remain in place and prevent upstream movement of fish in most flow conditions.

Ramp Downstream Face of Golf Course Dam (G1). The Fox Bend Golf Course Dam would be modified to provide fish passage by constructing a 20H:1V rock ramp on the downstream face and a 4H:1V slope on the upstream face of the dam. The dam structure would be left in place.

d. **Oswegoland Greenway (O)**. The measures designated by the letter "O" represent increments of restoration at the Oswegoland Park District Greenway. The measures are described below.

Oswegoland Greenway
O0 – no action
O1 – construct 1 lateral wetland (2.7 acre), d/s riffle
O2 – construct 2 lateral wetlands (2.7 & 2.4 acre), d/s riffle
O3 – construct 3 lateral wetlands (2.7, 2.4, 1.0 acre), 2 riffles
O4 – construct 3 lateral wetlands (2.7, 2.4, 1.0 acre), 2 riffles; no grassland plantings
O5 – Cut back and slope streambanks

No action (O0). This measure would result in no additional management efforts beyond the existing practices. No off-channel refuges existing in this reach of Waubonsie Creek. The riparian corridor has low diversity of vegetation and little wetland habitat. The stream channel has been straightened and has little to no instream diversity.

Construct 2.7-acre Lateral Wetland and Downstream Riffle (O1). A 2.7-acre "lateral" wetland would be constructed in the greenway adjacent to the stream at the downstream end of the Oswegoland Greenway area. A channel would be excavated between the wetland and the stream to allow fish to seek refuge in the wetland during high flow events. A riffle would be constructed in the creek downstream of connecting channel. The riffle would have a 20H:1V downstream face and a 4H:1V upstream face to allow fish passage. The riffle will provide flow and substrate diversity and the pool behind the riffle will provide depth diversity. The riffle will also provide more stable water levels in the lateral wetland. The wetland would be planted with seed and rootstock (plugs). The 19.0-acre grassland area surrounding the wetland and along the greenway would be planted to native grasses and forbs. A grade stabilization structure would be constructed downstream of the Pearce's Ford Road bridge.

Construct 2.7-acre and 2.4-acre Lateral Wetlands and Downstream Riffle (O2). 2.7-acre and 2.4-acre "lateral" wetlands would be constructed in the greenway adjacent to the stream at the downstream end and midpoint of the Oswegoland Greenway area, respectively. A channel would be excavated between the wetlands and the stream to allow fish to seek refuge in the wetlands during high flow events. A riffle would be constructed in the creek downstream of the 2.7-acre wetland-connecting channel. The riffles would have a 20H:1V downstream face and a 4H:1V upstream face to allow fish passage. The riffle will provide flow and substrate diversity and the pool behind the riffle will provide depth diversity. The riffle will also provide more stable water levels in the lateral wetlands. The wetlands would be planted with seed and rootstock (plugs). The 16.6-acre grassland area surrounding the wetland and along the greenway would be planted to native grasses and forbs. A grade stabilization structure would be constructed downstream of the Pearce's Ford Road bridge.

Construct 2.7-acre, 2.4-acre, 1.0-acre Lateral wetlands and 2 Riffles (O3). Three "lateral" wetlands would be constructed in the greenway adjacent to the stream – one 2.7-acre wetland, one 2.4-acre wetland and one 1.0-acre wetland at the downstream end, midpoint, and upstream end of the Oswegoland Greenway area, respectively. A channel would be excavated between the wetlands and the stream to allow fish to seek refuge in the wetlands during high flow events. Two riffles would be constructed in the creek downstream of the connecting channels of the 2.7-acre wetland and 1.0-acre wetland. The riffles would have a 20H:1V downstream face and a 4H:1V upstream face to allow fish passage. The riffles will provide flow and substrate diversity and the pool behind the riffle will provide depth diversity. The riffles will also provide more stable water levels in the lateral wetlands. The wetlands would be planted with seed and rootstock (plugs). The 15.6-acre grassland area surrounding the wetland and along the greenway would be planted to native grasses and forbs. A grade stabilization structure would be constructed downstream of the Pearce's Ford Road bridge.

Construct 2.7-acre, 2.4-acre, 1.0-acre Lateral wetlands and 2 Riffles, No Grassland Plantings (O3). Three "lateral" wetlands would be constructed in the greenway adjacent to the stream – one 2.7-acre wetland, one 2.4-acre wetland and one 1.0-acre wetland at the downstream end, midpoint, and upstream end of the Oswegoland Greenway area, respectively. A channel would be excavated between the wetlands and the stream to allow fish to seek refuge in the wetlands during high flow events. Two riffles would be constructed in the creek downstream of the connecting channels of the 2.7-acre wetland and 1.0-acre wetland. The riffles would have a 20H:1V downstream face and a 4H:1V upstream face to allow fish passage. The riffles will provide flow and substrate diversity and the pool behind the riffle will provide depth diversity. The riffles will also provide more stable water levels in the lateral wetlands. The wetlands would be planted with seed and rootstock (plugs). Grassland plantings will only occur on areas directly disturbed by construction of wetlands. A grade stabilization structure would be constructed downstream of the Pearce's Ford Road bridge.

Cut Back and Slope Streambanks (O4). This measure would involve cutting a 5-foot wide horizontal bench from the waters edge and cutting a 3H:1V slope to existing ground. This would be implemented between Pearce's Ford Road and Old Post Road and between Old Post Road and Barnaby Drive and would transition to the existing bank line within 50 feet of the bridge structures.

e. **Parkview Estates (P)**. The measures designated by the letter "P" represent increments of restoration at the Parkview Estates Detention Area. The measures are described below.

Parkview Estates
P0 – no action
P1 – construct 2.1-acre wetland
P2 – construct 3.2-acre wetland
P3 – construct 2.1 and 3.2 acre wetlands

No action (P0). This measure would result in no additional management efforts beyond the existing practices. The Parkview Estates Detention Facility has low diversity of wetland vegetation and much of the area is in reed canary grass.

Construct 2.1-acre Wetland (P1). A 2.1-acre wetland scrape would be created in the northern portion of the Parkview Estates Detention facility. The scrape will lower the ground elevation below the water table changing the conditions from saturated soils to shallow water (12-18 inches). More consistent water at or near the ground surface will reduce the competitive advantage of the reed canary grass and allow other plants to compete. The wetland scrape would be planted with plugs of native wetland vegetation.

Construct 3.2-acre Wetland (P2). A 3.2-acre wetland scrape would be created in the southern portion of the Parkview Estates Detention facility. The scrape will lower the ground elevation below the water table changing the conditions from saturated soils to shallow water (12-18 inches). More consistent water at or near the ground surface will reduce the competitive advantage of the reed canary grass and allow other plants to compete. The wetland scrape would be planted with plugs of native wetland vegetation.

Construct 2.1-acre and 3.2-acre Wetlands (P3). Two wetland scrapes would be created in the Parkview Estates Detention facility – one 2.1-acre wetland and one 3.2-acre wetland. The scrapes will lower the ground elevation below the water table changing the conditions from saturated soils to shallow water (12-18 inches). More consistent water at or near the ground surface will reduce the competitive advantage of the reed canary grass and allow other plants to compete. The wetland scrape would be planted with plugs of native wetland vegetation.

f. **Fox Valley Greenway (V)**. The measures designated by the letter “V” represent increments of restoration at the Fox Valley Greenway which is managed by the Fox Valley Park District. The measures are described below.

Fox Valley Greenway
V0 – no action
V1 – construct downstream riffle
V2 – construct 2 riffles

No action (V0). This measure would result in no additional management efforts beyond the existing practices. The stream channel has been straightened and has little to no instream diversity.

Construct Downstream Riffle (V1). One riffle would be constructed in the creek upstream of the Waterford Drive Bridge. The riffle would have a 20H:1V downstream face and a 4H:1V upstream face to allow fish passage. The riffles will provide flow and substrate diversity and the pool behind the riffle will provide depth diversity.

Construct 2 Riffles (V2). Two riffles would be constructed in the creek between Waterford Drive and Montgomery Road. The riffles would have a 20H:1V downstream face and a 4H:1V upstream face to allow fish passage. The riffles will provide flow and substrate diversity and the pool behind the riffle will provide depth diversity.

3. Evaluation of Alternatives

The costs and habitat benefits were estimated for each of the alternatives described above. Project costs include construction costs, but do not include land costs or annual operation and maintenance costs. Habitat benefits were estimated using Habitat Evaluation Procedures developed by the US Fish and Wildlife Service to document habitat quantity and quality. The Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA was used to model habitat quality of the stream reaches for use in evaluating habitat benefits of the fish passage alternatives at the Stonegate Dams (S), Pfund Dams (F) and Fox Bend Golf Course (G). The QHEI was also used to model instream benefits for the Fox Valley Greenway alternatives (V). Published models for the Marsh Wren, Eastern Meadowlark, and muskrat were utilized to model habitat benefits of the Oswegoland Greenway alternatives (O) and the Parkview Estates alternatives (P). No models were available to quantify the fish refuge benefits of the lateral wetlands at the Oswegoland Greenway; however, these benefits should be considered when selecting the recommended plan.

The estimated costs and habitat benefits are shown in Table 2, Table 3 and Table 4.

Table 2. **Fish Passage Alternatives -** Cost and environmental output

ALTERNATIVE	CONSTRUCTION COST*	ANNUALIZED COST *	AQUATIC OUTPUTS **
STONEGATE DAMS			
S0 – no action	$0	$0	
S1 – extend ramp	$139,456	$9,002	41.47
S2 – notch dam and extend ramp	$96,554	$6,233	41.47
S3 – extend ramp, add lower riffle	$188,184	$12,148	41.47
S4 – notch dam, extend ramp, add lower riffle	$145,282	$9,379	41.47
PFUND DAMS			
F0 – no action	$0	$0	
F1 – remove dam and replace with riffle	$106,938	$6,903	16.85
F2 – construct ramp on downstream dam face	$72,733	$4,695	16.85
F3 – remove dam, replace with riffle, add lower riffle	$136,084	$8,785	16.85
F4 – construct ramp on downstream face and add lower riffle	$101,879	$6,577	16.85
FOX BEND GOLF COURSE DAM			
G0 – no action	$0	$0	
G1 – ramp downstream face of dam	$19,092	$1,232	212.58

**Costs do not include Operation and Maintenance or land costs.*
***Habitat benefits are expressed as net Average Annual Habitat Units (AAHUs)*

Table 3. **Riparian Wetlands Alternatives** - Cost and environmental output

ALTERNATIVE	CONSTRUCTION COST*	ANNUALIZED COST *	WETLAND OUTPUTS **
OSWEGOLAND GREENWAY			
O0 – no action	$0	$0	
O1 – construct 1 lateral wetland (2.7 acre), d/s riffle	$710,713	$45,879	10.33
O2 – construct 2 lateral wetlands (2.7 & 2.4 acre), d/s riffle	$1,006,878	$64,998	12.35
O3 – construct 3 lateral wetlands (2.7, 2.4, 1.0 acre), 2 riffles	$1,140,753	$73,640	13.19
O4 – construct 3 lateral wetlands (2.7, 2.4, 1.0 acre), 2 riffles; no grassland plantings	$877,202	$56,627	7.39
O5 – Cut back and slope streambanks	$87,585	$5,654	
PARKVIEW ESTATES			
P0 – no action	$0	$0	
P1 – construct 2.1-acre wetland	$114,468	$7,389	6
P2 – construct 3.2-acre wetland	$161,530	$10,427	9.8
P3 – construct 2.1 and 3.2 acre wetlands	$275,998	$17,817	

**Costs do not include Operation and Maintenance or land costs.*
***Habitat benefits are expressed as net Average Annual Habitat Units (AAHUs)*

Table 4. **Aquatic Restoration Alternatives -** Cost and environmental output

ALTERNATIVE	CONSTRUCTION COST*	ANNUALIZED COST *	AQUATIC OUTPUTS **
FOX VALLEY GREENWAY			
V0 – no action	$0	$0	
V1 – construct downstream riffle	$18,840	$1,216	
V2 – construct 2 riffles	$37,848	$2,443	

**Costs do not include Operation and Maintenance or land costs.*
***Habitat benefits are expressed as net Average Annual Habitat Units (AAHUs)*

4. Comparison of Alternatives

Two analytical processes were conducted to provide decision-makers with the relative benefit-cost relationships of the various restoration alternatives. A cost-effectiveness analysis was conducted to ensure that the least cost solution is identified for each possible level of environmental output. Then, incremental cost analysis of the least cost solutions was conducted to reveal changes in costs for increasing levels of environmental outputs.

The fish passage/dam removal alternatives, wetland restoration alternatives, and instream restoration alternatives were compared separately as benefits were quantified using different models.

Figure 1 shows all alternative plans for fish passage/dam removal. Three of these alternative plans were cost-effective (Table 5). Table 6 shows that one restoration plan, S2F2G1, was identified as a "best buy" plan. A "best buy" plan is one that results in the most "bang for the buck". Alternative Plan S2F2G1 was identified as the Preliminary Recommended Plan for fish passage. The team is now evaluating dam removal or dam notching at the Upper Stonegate Dam. If either of these options are cost-effective and can maintain stream stability, the Preliminary Recommended Plan will be modified to include removal or notching of the Upper Stonegate Dam.

Figure 1. Fish Passage Alternative Plans

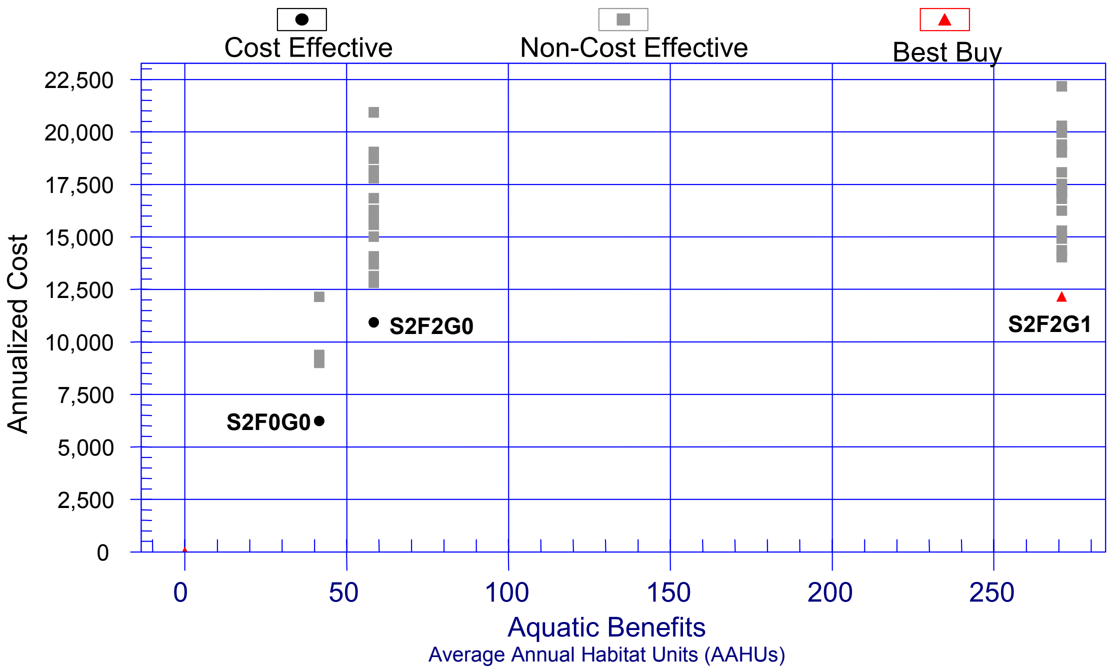

Table 5. Cost Effective Plans for Fish Passage

Combo Code	Total Cost	Annualized Cost	Aquatic Benefits (AAHUs)	Average Annual Cost/AAHU
S2 F0 G0	$ 96,554	$ 6,233	41.47	$ 150
S2 F2 G0	$ 169,287	$ 10,928	58.32	$ 187
S2 F2 G1	$ 188,379	$ 12,160	270.9	$ 45

Table 6. Incremental Analysis for Fish Passage

Combo Code	Total Cost	Annualized Cost	Aquatic Benefit	Average Annualized Cost/AAHU	Incr. Cost	Incr. Output	Incremental Cost per Output
S2F2G1	$ 188,379	$ 12,160	270.9	$ 45	$ 12,160	270.9	44.89

Figure 2 shows all alternative plans for wetland restoration. Nine of these alternative plans were cost-effective (Table 7). Table 8 shows that five "best buy" plans were identified. Alternative Plan O3P3 was identified as the Preliminary Recommended Plan for riparian wetland restoration. While the incremental cost for the Oswegoland Greenway alternatives jumps considerably, the study team felt that all three Oswegoland Greenway lateral wetlands should be constructed. The lateral wetlands will provide important fish refuge benefits which could not be included in the cost-benefit analysis due to habitat model limitations.

Figure 2. Riparian Wetland Restoration Alternative Plans

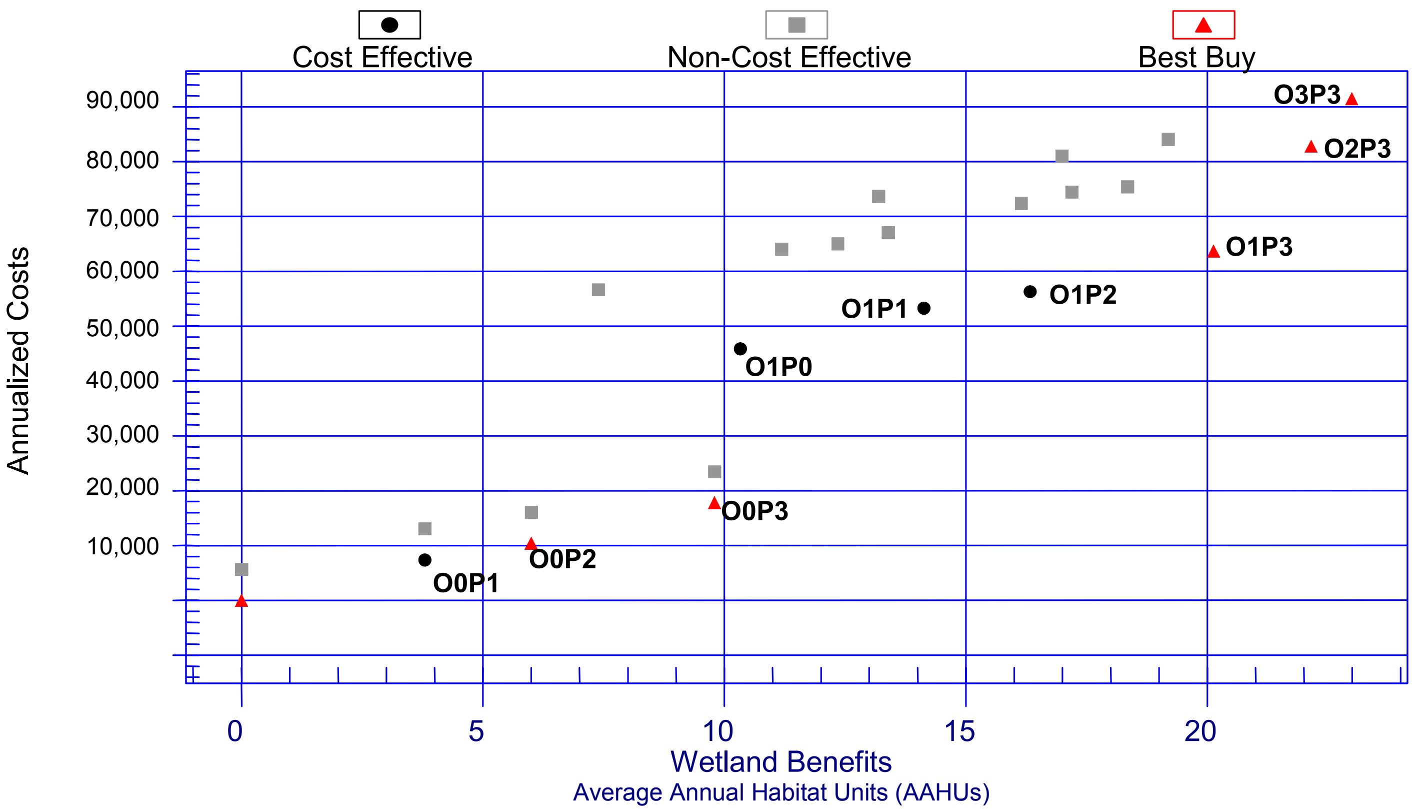

Table 7 Cost Effective Plans for Riparian Wetland Restoration

Combo Code	Total Cost	Annualized Cost	Wetland Benefit	Average Annual Cost/AAHU
O0P1	$ 114,468	$ 7,389	3.8	$ 1,944
O0P2	$ 161,530	$ 10,427	6	$ 1,738
O0P3	$ 275,998	$ 17,817	9.8	$ 1,818
O1P0	$ 710,713	$ 45,879	10.33	$ 4,441
O1P1	$ 825,181	$ 53,268	14.13	$ 3,770
O1P2	$ 872,243	$ 56,306	16.33	$ 3,448
O1P3	$ 986,711	$ 63,696	20.13	$ 3,164
O2P3	$ 1,282,876	$ 82,815	22.15	$ 3,739
O3P3	$ 1,416,751	$ 91,457	22.99	$ 3,978

Table 8. Incremental Analysis for Riparian Wetland Restoration

Combo Code	Total Cost	Annualized Cost	Wetland Benefit	Average Annualized Cost/AAHU	Incr. Cost	Incr. Output	Incremental Cost per Output
O0P2	161,530	10,427	6	1,737	10,427	6	$ 1,738
O0P3	275,998	17,817	9.8	1,818	7,390	3.8	$ 1,945
O1P3	986,711	63,696	20.13	3,164	45,879	10.33	$ 4,441
O2P3	1,282,876	82,815	22.15	3,739	19,119	2.02	$ 9,465
O3P3	1,416,751	91,457	22.99	3,978	8,642	0.84	$ 10,288

A preliminary recommended plan has not been identified for the Fox Valley Greenway.

5. Preliminary Recommended Restoration Plan.

The Preliminary Recommended Restoration Plan is S2 F2 G1 O3 P3. This includes the following features:

Stonegate

- Notch the Lower Stonegate Dam and extend the ramp downstream to a 20H:1V slope
- Modify the upper and lower riffles to create a 20H:1V slope on the downstream face and a 4H:1V slope on the upstream face and key into the streambanks.
- Armor left descending streambank downstream of the Upper Stonegate Dam to prevent the stream from creating a new channel bypassing the upper and lower riffle structures.
- Construct a rock ramp with a 20H:1V slope on the downstream face of the Upper Stonegate Dam to provide fish passage.

Pfund

- Modify the Upper Pfund Dam by constructing a 20H:1V rock ramp on the downstream face and a 4H:1V slope on the upstream face of the dam
- Remove the debris of the Lower Pfund Dam.

Oswegoland Greenway

- Construct three “lateral” wetlands with channels connecting them to the stream – one 2.7-acre wetland, one 2.4-acre wetland and one 1.0-acre wetland.
- Construct two riffles in the creek downstream of the connecting channels of the 2.7-acre wetland and 1.0-acre wetland.
- Plant native wetland vegetation in the wetlands
- Plant the 15.6-acre grassland area surrounding the wetland with native grasses and forbs
- Construct a grade stabilization structure downstream of the Pearce’s Ford Road bridge

Parkview Estates

- Create two wetland scrapes in the Parkview Estates Detention facility – one 2.1-acre wetland and one 3.2-acre wetland
- Plant wetland scrapes with plugs of native wetland vegetation.